

A REVIEW OF THE FISH-LEECHES OF THE INDIAN OCEAN*

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ABSTRACT

Based on the scattered but scanty literature, 12 genera and 23 species of fish-licees of the family Piscicolidae are known to be infesting a wide variety of fishes and turtles of the Indian Ocean, the adjacent seas and the river mouths. A key for the identification of these fish-licees to the species and a synopsis of information on each species including their records, size and colour ranges, hosts, biology and behaviour and geographic and host distribution in and outside the limits of the Indian Ocean are all provided. Some general observations concerning the ecology and the relationship of these fish-licees are included.

INTRODUCTION

OF the nearly 46 genera and 123 species of fish-licees of the family Piscicolidae known so far, only 12 genera and 24 species seem to occur within the limits of the Indian Ocean, the adjacent seas and river-mouths etc., However, considering the facts that some valid species and even genera from this ocean have been recorded only once so far, sometimes known by just a few or even a single specimen and that there is such a wide diversity of external and internal organisation in the various known forms and that there are ever so many species of fish in the Indian Ocean still unknown as hosts for fish-licees, one may presume that there should be a lot more genera and species of fish-licees yet to be discovered and described from the Indian Ocean. Fish-licees are currently best known from the seas and oceans adjacent to and from the coasts of the countries with well developed fisheries programmes or marine or oceanographical institutions, so that our information on the fish-licees of the developing countries around the Indian Ocean is comparatively rather poor. The following review is based on the author's own published and unpublished work on fish-licees of the Indian Ocean as well as on the available literature on the subject. It is hoped that this would not only interest fishery biologists but would also enable a better watch out for more fish-licees and information on them from the Indian Ocean.

I am to appreciate the work of Dr. A. Soos whose catalogue of the family Piscicolidae has greatly helped my attempt of this work and I am grateful to Dr. Marvin C. Meyer and Dr. P. H. D. H. De Silva for helping me with some of the original papers I needed. I am to express my thanks to Dr. Chandran D. S. Devanesen, Principal of the Madras Christian College for the travel grant sanctioned for presenting this paper at this symposium.

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TAXONOMY

Genus *AUSTROBDELLA* Badham, 1916*Austrobdella bilobata* Ingram, 1957

Austrobdella bilobata Ingram, 1957.

Known only from the original record of 51 specimens collected from 296 flounders, *Rhombosolea tapirina* Gunther, taken at Pittwater, Tasmania. 6.0 to 32.0 mm long, bluish-black, semitransparent.

Biology and behaviour : This species usually lives attached to the dorsal side of the host, above the body cavity. Details of movements of adults, copulation, deposition of egg capsules on foreign objects at night, fecundity and hatching of a single young one from each capsule after about 3 to 4 months are all observed and recorded by Ingram (1957). These leeches are noted to be rather hardy ones, continuing to live on the hosts even after the death of the hosts. They seem to produce ulcerated patches and extensive scars on the bodies of their hosts but never on their fins.

Geographic distribution : So far known from the Tasmanian waters only.

Remarks : Ingram (1957) has provided a useful Table comparing the three known species of this genus.

Genus *BRANCHELLION* Savigny, 1822*Branchellion angeli* Sigalas, 1921

Branchellion angeli Sigalas, 1921 and 1927 ; Moore, 1957.

Sigalas' (1921) information is unavailable to the author.

Moore (1957) has described six specimens ranging from 12.0 to 27.0 mm in total length, one from an electric ray in Durban Bay, four from the belly of *Squatina* shark, Bluff, Durban and one from a ray, Sheffield Beach, S. coast of Natal.

Biology and behaviour : This species is not known so far in live condition.

Geographic distribution : Sigalas' specimens come from the Vizcaya Bay, Natal but Moore's specimens are from Durban and the coast of Natal. So far this species is known from the coast of Natal only.

Remarks : Perhaps by a faulty counting, Sigalas (1921, 1927) has attributed only 32 pairs of gills for this species but according to Moore (1957) it has 33 pairs of gills.

Branchellion australis Leigh-Sharpe, 1916

Branchellion australis Leigh-Sharpe, 1916 ; Richardson, 1949; Ingram, 1957.

Six specimens from the Museum of South Australia, Adelaide, recorded to have been collected from a skate, *Raja lemprieri* Richardson, at Port Victor, South Australia.

lia constitute the original and the only record of this species. Largest specimens are 35.0 mm long with 4, 8 and 4 white spots respectively on the first, second and third annuli of each abdominal segment. Background colour of these leeches is greyish black.

Biology and behaviour : This species is not known so far in live condition.

Geographic distribution : Known from South Australia only so far.

Remarks : Leigh-Sharpe (1916) has described the detailed external and internal morphology, based on preserved material. Richardson (1949) mentions this leech as a tuberculate one but perhaps the white spots referred to by Leigh-Sharpe in his original description are confused for tubercles. Ingram (1957) also points out the same discrepancy in Richardson's description.

Branchellion parkeri Richardson, 1949

Branchellion rajae Parker, 1892.

Branchellion parkeri Richardson, 1949 and 1953 ; Ingram, 1957.

Several specimens have been collected from *Raia lemprieri* Richardson, from the North-west Bay and Port Sorell and also from *Pristiophorus* sp. at Port Sorell and from *Dasyatis* sp. at Pittwater, all in Tasmania.

These specimens from the Tasmanian waters measure upto 75.5 mm long and are of patterned dark phase, as described by Richardson (1953) for the Dunedin specimen and for the two specimens from off Cape Campbell, New Zealand.

Biology and behaviour : This is known to be a very inactive leech, incapable of swimming. This is perhaps the reason why it is so common on the bottom-feeding fish like skates and rays. Very often this leech leaves an eroded scar on the host, created by the firm attachment to the host by its posterior sucker.

Geographic distribution : Outside Tasmania, this leech is very common in New Zealand waters. *Raia nasuta* in Cook Strait, common dogfish, *Mustelus antarcticus* in the vicinity of Wellington and the holocephalan, *Callorhynchus milii* seem to be the known hosts in the New Zealand waters. These leeches have been trawled off Dunedin and off Cape Campbell, New Zealand.

Remarks : There is a colourless variety, more common in the New Zealand waters. Tasmanian forms have little frilled gills compared to the New Zealand forms. Ingram (1957) compares in a table, all the known species of the genus *Branchellion*.

Branchellion plicobranchus Sanjeeva Raj, 1953

Branchellion sp. Moore, 1944.

Branchellion plicobranchus Sanjeeva Raj, 1953 ; 1954 and 1960.

A single specimen from the marbled torpedo ray at the Assumption Island, another from a fish-market at Madras, several from *Dasyatis uarnak* at Adhirama-pattinam and one from the nostrils of *Carcharias* sp. at Vizagapatam, all on the

Indian coast of the Bay of Bengal, and several from Quilon and Bombay on the Indian coast of the Arabian Sea, are all referred to by Sanjeeva Raj (1960).

Each of the three annuli of the abdominal segments is biannulated and the highly frilled gills arise from the anterior half of each annulus. Maximum length noted is about 64.0 mm and it has a grey background colour with white streaks or cream coloured ones, irregularly anastomosing. There is a darker colour phase also with no white or cream streaks on it.

Biology and behaviour : This is a very sluggish leech in live condition and is not as contractile or extensile as the freshwater or land leeches. It has a very firm grip on the hosts by its posterior sucker. As soon as the host fishes are landed on the shore or in a boat or basket, these leeches try to crawl away, back into water.

Geographic distribution : This leech seems to be distributed in the seas around India and in the waters east of south Africa.

***Cystobranthus anoculatus* Kaburaki, 1921**

Cystobranthus anoculatus Kaburaki, 1921b.

Three specimens from an unknown locality in India are assigned to this species, said to be closely resembling *Cystobranthus mamillatus*. They are about 21.0 mm long and are of dirty brown colour with darker shade at the clitellum.

Biology and behaviour : Not known.

Geographic distribution : Known from India only so far.

Remarks : This may be a freshwater species.

***Johanssonia platycephali* Ingram, 1957**

'*Ichthyobdella*' *platycephali* Ingram, 1957.

Ingram (1957) has described two specimens taken from a flathead, *Platycephalus bassensis* C & V. from Catamaran, Tasmania. The largest of them is 23.0 mm long. Dorsum and sides are brown with three pairs of light bands.

Biology and behaviour : Not known.

Geographic distribution : Known only from Tasmania so far.

***Malmiana stellata* Moore, 1958**

Ottoniobdella stellata Moore, 1958.

Two specimens are taken off a tobyfish from Richard's Bay, Natal, on a single occasion only so far. 15.7 mm long, yellowish grey, speckled dorsally and ventrally by stellate black chromatophores.

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Biology and behaviour : Not known.

Geographic distribution : Known from the coast of Natal only so far.

***Ozobranchus branchiatus* (Menzies, 1791)**

Eubranchella branchiatus Baird, 1869.

Ozobranchus branchiatus Ghosh *et al.*, 1963 ; Sanjeeva Raj, 1966.

Baird (1869) described several of these, about half an inch long, collected by Mr. Rayner from a turtle in the Shark's Bay, Australia. Ghosh *et al.*, (1963) collected about 15 specimens from a turtle on the coast of the Pirotan Island, Gulf of Kutch. Sanjeeva Raj (1966) described several from the plastron of *Chelonia mydas* (Linn.) from the Pulicat Lake on the Indian coast of the Bay of Bengal, about 35 miles north of the city of Madras. They measure 2.0 to 9.0 mm long and are cream or buff coloured, in live condition.

Biology and behaviour : This species of leech is always associated with *Chelonia mydas* (Linn.). Several hundreds of them are sometimes collected from a small area on the host body, often associated with oozing patches or on fibro-epithelial tumours on eye-lids or neck or mucous junctions of mouth and nostrils. They can withstand exposure and even desiccation for two or three days. Egg capsules are usually attached to the host itself.

Geographic distribution : This is one of the most cosmopolitan fish-lice known, distributed along with its cosmopolitan hosts, *Chelonia mydas* (Linn.) in the tropics and subtropics.

This species of leech is known also from the vicinity of the Isles of Ogaswara popularly called as the Bonin Islands (Oka, 1895), from off Sarawak, Talang Talang, Besa Islands in the south China Sea (Hendrickson, 1957, Sanjeeva Raj and Penner, 1962 and De Silva, 1963), from Key West, Florida (MacCallum and MacCallum, 1918), from the west coast of Florida (Nigrelli, 1941 and 1942, Nigrelli and Smith, 1943) and from Cedar Keys, Florida (Sanjeeva Raj and Penner, 1962).

***Ozobranchus margoi* (Apathy, 1890)**

Ozobranchus margoi Sanjeeva Raj, 1959.

Over a thousand specimens are collected and recorded by Sanjeeva Raj (1959), from the right forelimb of a single *Eretmochelys imbricata* on the Indian coast of the Bay of Bengal at Ennore, about 12 miles north of the city of Madras. They measure 5.0 to 19.5 mm long and are cream coloured in the preservative.

Biology and behaviour : Little is known of its biology since its descriptions are always based on preserved material.

Geographic distribution : The original specimens come from the Bay of Naples collected on *Thalassochelys corticata* and described by Apathy (1890). Two specimens from *Caretta olivacea* on the coast of Fukoka, Japan and two more from

Delphinus longirostris from the sea of Sagami, have been described by Oka (1927). Cordero (1929) records it from *Thalassochelys caretta* from Monivenico, Uruguay, South America.

Ozobranchus papillatus Kaburaki, 1921

Ozobranchus papillatus Kaburaki, 1921b ; Sanjeeva Raj, 1954.

Collected from the body of the tortoise *Kachuga tectum tentoria* Gray, from the River Narmada in Nagpore, India. Contracted specimens measure about 7.0 mm in total length and are grey in colour.

Biology and behaviour : Not known.

Geographic distribution : So far known from India only.

Remarks : Sanjeeva Raj (1954) has discussed its taxonomic status.

Ozobranchus polybranchus Sanjeeva Raj, 1951

Ozobranchus polybranchus Sanjeeva Raj, 1951 and 1954.

A single specimen was collected from the tortoise, *Pelochelys bebroni* (Grey) from the mouth of River Kille (Vellar Estuary) at Porto Novo, on the Indian coast of the Bay of Bengal. 32.0 mm long and greenish-yellow in live condition.

Biology and behaviour : Attached firmly to the host by its posterior sucker. Gills show slight wavy movements in water. Comparatively a slow moving leech.

Geographic distribution : Known from the original record only from the Indian coast of the Bay of Bengal.

Remarks : This may be a brackishwater species.

Ozobranchus shipleyi Harding, 1909

Branchellion sp. Robertson, 1908.

Ozobranchus shipleyi Harding, 1909 ; Robertson, 1910.

Ozobranchus jantseamus Kaburaki, 1921b.

Ozobranchus shipleyi Sanjeeva Raj, 1954.

This species has been collected on several occasions from the Hard-shelled terrapin, *Melanochelys (Nicoria) trijuga thermalls* (Lesson), in Ceylon and South India, from *Kachuga intermedia* in the River Mahanadi, from *Kachuga smithi* Gray, in the River Ravi, Lahore and from *Kachuga dhongoka* Gray in the River Ganges. It is common on tortoises along the brackishwaters of Alleppey and Ernakulam on the west coast of India.

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Biology and behaviour : Egg capsules are attached to the body of the hosts. When these hosts wander onto land at night, as they do, these leeches are capable of withstanding exposure for considerable time.

Geographic distribution : Widely distributed in the fresh and brackishwaters in India and Ceylon.

Remarks : Robertson (1908 and 1910) has shown this species to be a vector for trypanosomes of chelonians.

***Piscicola caeca* Kaburaki, 1921**

Piscicola caeca Kaburaki, 1921a ; Harding, 1927.

Three or four specimens are taken from the lips of the sting ray, *Trygon sephen* Forsskal in the Chilka Lake, Orissa State, on the Indian coast of the Bay of Bengal. About 13.0 mm in total length.

Biology and behaviour : Not known.

Geographic distribution : So far known from the Chilka Lake only in India.

Remarks : This is a brackishwater leech and is an exception in the genus, in not having the pulsating vesicles at the sides of the abdomen.

***Piscicola olivacea* Harding, 1920**

Piscicola olivacea Harding, 1920 and 1927.

Known from the lower surface of the body, gill slits, near anus, within the mouth and palate of *Trygon sephen* Forsskal. Also known from the globe fish, *Tetrodon reticularis* and from *Chatoessus chacunda*. All these records are from the brackishwaters of the Chilka Lake. They have also been collected from a freshwater pool on Barkuda Island in the Chilka Lake. They measure about 10.75 mm long.

Biology and behaviour : Not known.

Geographic distribution : Moore (1924) has described two specimens from Soochow in China, one 9.0 mm and the other 17.2 mm long.

***Pontobdella aculeata*, Harding, 1924**

Pontobdella aculeata Harding, 1924 and 1927 ; De Silva, 1963.

Two specimens, one from *Harpodon nehereus* from the estuary of the Bassein River in Burma and the other from the Gregory Isles, Mergui Archipelago, Burma, have been reported by Harding (1927). One measures 64.0 mm and the other 35.0 mm long. One is dull grey in alcohol and the other reddish brown with a dorsal pair of dark brown linear spots on the sensory annulus of each segment.

De Silva (1963) recorded one from the Fisheries Factory, Mutwal, Ceylon where the fish from the Wadge Bank in Ceylon have been stored. This leech measures 23.6 mm in total length and is pale yellowish to brown in colour under preserved conditions. The green transverse bands of live condition seem to disappear in the preservative but some of the scattered dark-brown spots and irregular brown blotches remain.

Biology and behaviour : Not known.

Geographic distribution : Known so far from the Burma coast of the Bay of Bengal, from the Andaman Sea and from the Wadge Bank in Ceylon.

***Pontobdella australiensis* Goddard, 1909**

Pontobdella australiensis Goddard, 1909.

Under the descriptions of the Australian Hirudinea, Goddard (1909) has described 13 specimens of which the extended one measures about 20.0 mm long and has a yellow neck and bluish grey or blue body.

Biology and behaviour : Not known.

Geographic distribution : Known only once so far, from the type locality.

***Pontobdella loricata* Harding, 1924**

Pontobdella loricata Harding, 1924 and 1927.

Only a single specimen taken from an unknown host, by the Marine Survey of India is known so far. This measures about 74.0 mm long.

Biology and behaviour : Not known.

Geographic distributions : Not known after the original record from the Indian seas.

***Pontobdella rayneri* Baird, 1869**

Pontobdella rayneri Baird, 1869 ; Johansson, 1911 ; Moore, 1957.

Baird (1869) describes a single specimen taken from a species of *Rhinobatus* in Shark's Bay near Denham, Australia. When relaxed it was about an inch long.

Johansson (1911) also had a single specimen, 10.0 mm long, also taken at Shark's Bay on a *Rhinobatus*.

Moore (1957) has described five specimens, the largest being an inch long, all taken from the fin of a Port Jackson shark, *Heterodontus philippi* caught off Hobart, Tasmania.

Biology and behaviour : Not known.

Geographic distribution : Known from Western Australia and Tasmania.

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***Pontobdella tasmanica* (Hickman, 1942)**

Pontobdella verrucosa Hickman, 1942.

Pontobdella tasmanica Hickman, 1947 ; Ingram, 1957.

Originally a single specimen with its egg capsules was found in a shell washed ashore on the beach at Sandy Bay, Hobart, Tasmania. This was about 37.0 mm long, light brown in live condition with a dark brown triangular patch on the dorsum of the anterior sucker. In alcohol, it changes to uniform mustard yellow except for the patch on the anterior sucker.

A second specimen described by Ingram (1957), about 12.0 mm long was attached to a piece of *Ulva* on the Kingston Beach Tasmania, and another, the largest of the three known was about 80.0 mm long collected from a skate at Brig Rocks, King Island, north-west of Tasmania.

Biology and behaviour : 31 egg capsules, each 2.61 mm long and 1.63 mm wide, oval and smooth, leathery in texture and of transparent brown colour, have been deposited by a single leech. The parent always preferred to lie coiled around these capsules. 17 of the capsules hatched after about a month and just one leech emerges out of each capsule.

Geographic distribution : Known so far from the waters around Tasmania only.

***Pontobdellina macrothela* (Schmarda, 1861)**

Pontobdella macrothela Blanchard, 1897 ; Soos, 1965.

Pontobdella (Pontobdellina) macrothela Harding, 1927 ; Moore, 1958 ; De Silva, 1963.

The single specimen described by Harding (1927) was secured from the side of a hammer-headed shark, *Zygaena* sp. caught at a depth of 25-28 fathoms, off Gopalpore, on the Indian coast of the Bay of Bengal. This specimen was about 64.0 mm long in alcohol, dark green in live condition, fading in alcohol to pale greenish-brown hue all over except the two dark brown spots on the anterior sucker.

Blanchard (1897) seems to have collected a similar specimen from Tandjong, Sumatra (Malacca and Singapore Straits).

Moore (1958) described one from fishes on the north coast of Natal and another from a hammer-headed shark at Durban, Natal, and possibly a third specimen from the tongue of *Lamna nasus* at Durban, Natal. Perhaps the largest forms are included in this collection from Natal, one of them measuring 90.0 mm long, black-green or dark-olive green with three bands of dark brown, in live condition. Preserved material is uniform yellow-brown in colour.

De Silva (1963) describes four specimens collected from the Fisheries Factory at Mutwal, Ceylon where fishes trawled off the Wadge Bank of Ceylon are emptied. Also, one live specimen from the Wadge Bank was taken from the head of *Rhina ancylostoma* (Bloch and Schneider), and another from the pectoral fin of *Stegostoma fasciatum* (Hermann) from the Wadge Bank. The largest of these collections is

about 88.0 mm long and the others 55.0 to 65.0 mm long. They are bluish-green to dark green in colour, in live condition.

De Silva (1965) mentions of two specimens taken from a shark off Singapore and two more from Kalpitiya (North-west Province) of Ceylon. Both these lots are said to be chocolate to umber brown in colour.

Biology and behaviour : Although it is a rather common leech, no one seems to have observed it for a considerable time, under live conditions. These leeches also seem to crawl away from the hosts, soon after the hosts are landed.

Geographic distribution : This is a cosmopolitan species known from the tropics and subtropics. Outside the Indian Ocean, it is known from Kingston Harbour, Jamaica (Schmarda, 1861), Brisbane Harbour, Australia (Goddard, 1909), Gulf of Mexico (Caballero, 1955), from Fokien, China, Pacific Costerica, Culebra, Pacific Guatemala, Acajutla and Candlemas Islands in the Antarctica (Augner, 1932). Those from China are said to be the largest, measuring about 105.0 mm long.

Remarks : This is perhaps the largest of the fish-leeches known and this is always taken from elasmobranchs.

***Pterobdella amara* Kaburaki, 1921**

Pterobdella amara Kaburaki, 1921 a ; Harding, 1927 ; Jayadev Babu, 1967.

These are known originally from the gums of the sting ray, *Trygon sephen* Forsskal and from the gums of *Trygon uarnak* Forsskal, from the Chilka Lake on the Indian coast of the Bay of Bengal. They measure 10.0 to 12.0 mm long. Jayadev Babu (1967) collected them from the gums of *Trygon sephen* Forsskal on the Pulicat Lake, also on the Indian coast of the Bay of Bengal. These are 15.0 to 20.0 mm long, and in live condition, they are flesh coloured.

Biology and behaviour : Their attachment to the hosts by their posterior sucker is so strong that when they are pulled off, the host epithelium also peels off. These leeches are noticed to live attached to the host long after the death of the hosts.

Geographic distribution : Known so far from the brackishwaters on the east coast of India.

***Trachelobdella leptcephali* Ingram, 1957**

Trachelobdella leptcephali Ingram, 1957.

Ingram (1957) records nine specimens taken from the gills of the conger eel, *Leptocephalus conger* (Linnaeus) from Tasmania. They measure 12.0 to 20.0 mm long.

Biology and behaviour : Not known.

Geographic distribution : Known from Tasmanian waters only.

Remarks : The tubular posterior sucker appears to be well adapted for attachment to the gill filaments of the host fish.

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Zeylanicobdella arugamensis De Silva, 1963

Zeylanicobdella arugamensis De Silva, 1963 and 1965 ; Jayadev Babu, 1967.

Large numbers of them were originally collected from the brackishwaters of Arugam Kalapu, Eastern Province in Ceylon. The hosts were *Tachysurus maculatus* (Thunberg), *Macrones gilio* (Hamilton-Buchanan), and *Tilapia mossambica* (Peters). Subsequently, they were taken from *Glossogobius giuris* (Hamilton-Buchanan) at Kathaluwa, Southern Province in Ceylon. These are 6.0 to 7.5 mm long and pale yellow ochre. De Silva (1965) records them from the gills of the spotted bat fish, *Drepane punctata* from Puttalam lagoon near Kalpatiya. De Silva (1965) describes three more specimens from the body of the common sea horse, *Hippocampus kuda* Bleeker and four others from a marine eel caught off Singapore. The largest of these are 9.0 mm long. The posterior sucker of the Malayan forms has 14 radial bands by which De Silva (1965) assigns them to a variety *radiata*. Jayadev Babu (1967) collected and described 41 of these specimens from the canine cat fish, *Plotosus canius* Hamilton-Buchanan, from the Pulicat Lake on the Indian coast of the Bay of Bengal. They measure 3.0 to 10.0 mm long.

Biology and behaviour. These leeches are often found attached to the chin, opercular region and sides of the head of the host fishes. These leeches can crawl or swim and are responsive to light. They attach to marine fish also that enter into brackish waters but seem to be chiefly in brackishwater environments.

Geographic distribution: Known so far from the brackishwaters of India, Ceylon and Malasia.

BIONOMICS

Size and colours: Fish-leeches of the Indian Ocean range in length from a few millimetres to about 90.0 mm, as exemplified by *Pontobdella macrothela* (Schmarda), but the average length is between 15.0 and 25.0 mm.

They are usually light coloured, in shades of grey or cream or brown, the smaller translucent ones matching with the colour of the hosts but the larger opaque ones may not.

Habitat: The marine fish-leeches are known mostly from the coastal waters of the Indian Ocean, but perhaps with intensive fishing or trawling, one would come across them in the offshore waters also. *Pontobdellina macrothela* (Schmarda) is known from a depth of about 28-30 fathoms, off Gobalpore in the Bay of Bengal but the other marine leeches are taken from shallower waters of the Indian Ocean.

Brackishwater species like *Zeylanicobdella arugamensis* De Silva, *Pterobdella amara* Kaburaki, *Piscicola caeca* Kaburaki and *Piscicola olivacea* Harding, attach to fishes which move both into the adjacent inshore waters as well as into freshwaters.

Just a few forms like *Ozobranchus papillatus* Kaburaki, may be purely freshwater species.

Biology and behaviour : In general, fish-leeches often reach the hands of the experts, in a preserved state, so that our information on their biology is rather scanty. Some species of *Branchellion* and *Pontobdella* tend to crawl away from their hosts, soon after the hosts are taken out of water but others like *Pterobdella* and *Ozobranchus* stick on to their hosts, even for two or three days after the hosts are thrown ashore. These leeches are perhaps protected from dessication by the mucous secretions of their own bodies as well as those of their hosts.

Fish-leeches are not so extensile as the other groups of leeches. They are sluggish and can crawl on the host body but some can afford to swim a little.

So far as the breeding is concerned, it is known that species of *Ozobranchus* attach their egg capsules to the body of their chelonian hosts but most of the other fish-leeches are known to crawl away from their hosts at the time of the deposition of egg capsules and deposit them on foreign objects. The adults perhaps die after depositing the egg capsules. Most often, egg capsules are oval in shape, transparent when fresh but opaque brown and of leathery texture when dried up and bear two plugs at either ends. Each egg capsule contains a single developing young one and it takes about two to three months for the young ones to develop and emerge out.

Host relations : Of the fish-leeches of the Indian Ocean, species of the genus *Ozobranchus* alone are known to be infesting chelonians but the rest of the genera and species infest both elasmobranchs and teleosts.

Species like *Ozobranchus branchiatus* (Menzies) seem to be host specific to *Chelonia mydas* (Linn.) but the others infest any host within the broad group of chelonians in the case of the species of *Ozobranchus*, elasmobranchs for species of *Branchellion*, *Pontobdella*, *Pontobdellina* and *Pterobdella* etc., and teleosts for other genera and species. Perhaps brackishwater fish-leeches have a wide range of hosts as in the case of *Zeylanicobdella arugamensis* De Silva, taken so far from at least seven different teleostean hosts.

Fish-leeches infesting hosts which are cosmopolitan in their distribution as in the case of *Ozobranchus branchiatus* (Menzies) on *Chelonia mydas* (Linn.), have a wide geographic distribution.

Each species of leech seems to infest a specific area of the host body like the gills, fins, skin beneath the scales and gums and other soft areas adjacent to natural orifices. Perhaps, these leeches attach themselves to their hosts on their ventral surface and crawl on to reach their final destinations.

So far as the damage to the hosts is concerned, it is quite unlikely that on the open sea, unlike as in an enclosed pond, fish-leeches could be the cause of mass mortality of fish, however heavy the infestation might be on a random sample of fish. Nigrelli (1941 and 1942), Nigrelli and Smith (1943), Hendrickson (1958), Smith and Coates (1938 and 1939) and Smith, Coates and Nigrelli (1941) have well established that species like *Ozobranchus branchiatus* (Menzies) might be in some way or other related to the growth of the fibro-epithelial tumours on the soft parts of their hosts, *Chelonia mydas* (Linn.).

Larger leeches like species of *Branchellion* and *Pontobdellina* may leave a lacerating circular scar on the host body, caused by the firm attachment by their posterior sucker but smaller leeches like *Austrobdeella bilobata* Ingram, may leave extensive

ulcerated patches on the body and fins of their hosts. In such cases, the fins may get mutilated handicapping the movements of the fish and such ulcerated spots may be serving as portals of entry for viral, bacterial and fungus attack, thus facilitating secondary infection.

Robertson (1909) has demonstrated at Plymouth that the sexual phase in the life-cycle of *Trypanosoma raiæ* of rays and skates, takes place in the gut of their ectoparasitic leech, *Pontobdella muricata* (Linn.). In the same way, Robertson (1910) has shown in Ceylon that the sexual phase of *Haemogregarina nicoræi* Cast, Willey, parasitic in the blood of the hard-shelled terrapin *Melanochelys (nicoræi) trijuga thermalis* takes place in their ectoparasitic leech, *Ozobranchus shipleyi* Harding. Although the actual transference of the blood parasites is not demonstrated, yet it is presumed that these leeches being proboscis feeders on the blood and body juices of the hosts and they being the exclusive ectoparasites of these hosts, they must be serving as vectors for the blood parasites among their chelonian and piscine hosts.

Geographic distribution : The fish-leech fauna of the Indian Ocean, so far known, is comparatively poor, considering the richness of the animal fauna known from the Indo-Malayan region of the warm water fauna. Most of the fish-leech fauna of this region is known only from the continental shelf and that too from the Indian coast. It is strange that not a single fish-leech is known so far from the Red Sea, Gulf of Aden, Persian Gulf, Gulf of Oman and that the richest fauna of fish-leeches of the Indian Ocean is known from the Bay of Bengal. Only one out of the twelve genera known from the Indian Ocean, amounting to only 8.3% may be endemic but 20 out of the 24 species, known, amounting to 83.3% is endemic so that endemicity is comparatively high at the specific level and very low at the generic level.

Of the fish-leeches of the northern Indian Ocean, some marine forms like *Ozobranchus branchiatus* (Menzies) and *Ozobranchus margoi* Apathy, which infest widely distributed hosts have a world-wide distribution, within the tropics and subtropics. Others like *Branchellion plicobranchus* Sanjeeva Raj, are known from the northern Indian Ocean only but freshwater and brackishwater species like *Cystobranchus anoculatus* Kaburaki, other species of *Ozobranchus*, species of *Piscicola* and *Pterobdella* are extremely restricted to a narrow region except *Zeylanicobdella arugamensis* De Silva, which is known from the brackishwaters of countries abutting the Bay of Bengal.

A detailed paper on the affinities and geographic distribution of the fish-leeches of the southern Indian Ocean, is presented by this author, elsewhere at this symposium. It may, however, be summed up here that the fish-leeches of the southern Indian Ocean bear relations with those of the adjacent northern Indian Ocean on one side and with those of the Antarctic on the other side. They are also related to the northern temperate and polar forms.

Scope for further work : As indicated elsewhere in this paper, there is a great paucity of information on the known fish-leeches of the Indian Ocean, particularly concerning their life-cycles and biology. As shown by Robertson (1909 and 1910), Hickman (1942), Richardson (1949) and Ingram (1957), it is not too difficult to maintain fish-leeches alive in aerated aquaria and to observe the complete life-cycle and to study their host relations. Also, a more interested search for them, will certainly bring to light many more species of fish-leeches yet unknown to science from this vast and varied area of the Indian Ocean.

KEY TO THE GENERA AND SPECIES OF THE FISH-LEECHES OF THE INDIAN OCEAN

1. Gills on either sides of abdomen present.....2
Gills absent.....10
2. Gills digitiform, several filaments on a single or divided stem.....3
Gills foliaceous, simple or with frilled lobes7
3. Five to eleven pairs of gills.....4
21 pairs of gills.....*Ozobranchus polybranchus*
4. Five to seven pairs of gills.....5
11 pairs of gills.....6
5. Five pairs of gills.....*Ozobranchus margoi*
Seven pairs of gills.....*Ozobranchus branchiatus*
6. Biannulate abdominal segments, both annuli of equal size and both bear papillae.....*Ozobranchus papillatus*
Biannulate abdominal segments, anterior annulus larger, papillae present on anterior annulus only.....*Ozobranchus shipleyi*
7. 31 pairs of gills.....8
33 pairs of gills.....9
8. 11 pairs of pulsating vesicles and six pairs of testes....*Branchellion australis*
10 pairs of pulsating vesicles and five pairs of testes....*Branchellion parkeri*
9. Bilobed hump on the ventral side of segment VII.....*Branchellion angeli*
Bilobed hump is absent.....*Branchellion plicobranchus*
10. Fin-like extensions along the sides of neck and abdomen..*Pterobdella amara*
Suck fin-like extension absent.....11
11. Pulsating vesicles present at the sides of abdomen but papillae absent on body 12
Pulsating vesicles absent at the sides of abdomen but papillae may or may not be present on body.....15
12. Seven annuli for abdominal segments.....*Cystobranchus anoculatus*
Six or fourteen annuli for abdominal segments 13
13. Six annuli for abdominal segments and five pairs of testes.....
.....*Trachelobdella leptcephali*
14 annuli for abdominal segments and six pairs of testes.....14
14. Eyes present.....*Piscicola olivacea*
Eyes absent (Pulsating vesicles also absent as an exception in the genus)....
.....*Piscicola caeca*
15. Papillae or tubercles absent on body.....16
Papillae or tubercles present on body.....18
16. Pulsating vesicles rudimentary and embedded in body wall.....
.....*Johanssonia platycephali*
Pulsating vesicles totally absent ; post caeca distinct or fused.....17

17. Post caeca distinct and paired ; 10-14 ocular spots on posterior sucker.....
*Malmiana stellata*
 Post caeca fused ; ocular spots absent.....*Austrobdella bilobata*
18. Neck and abdomen distinct.....*Pontobdelliana macrothela*
 Neck and abdomen indistinct.....19
19. Three-annulate abdominal segments.....20
 Four-annulate abdominal segments.....*Pontobdella aculeata*
20. Two large brown pigment spots on anterior sucker present..*Pontobdella rayneri*
 Such pigment spots are absent on the anterior sucker.....21
21. Tubercles on sensory annulus, six in number.....*Pontobdella australiensis*
 Tubercles on sensory annulus eight in number.....22
22. Clitellum with five annuli.....*Pontobdella tasmanica*
 Clitellum with seven annuli.....*Pontobdella toricata*

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